Original Article

Quality of life and influencing factors of coal miners in Xuzhou, China

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Background: Coal industry is one of the national pillar industries in China. A large number of coal miners are exposed to various occupational hazards, which might cause occupational disease. The aim of the study was to assess the quality of life (QOL) of coal miners in Xuzhou, China and explore influencing factors to QOL of coal miners.

Methods: Six hundred and twelve underground miners and 354 ground workers in one of coal mines of Xuzhou were enrolled in our study. The 36-item Short-Form Health Survey (SF-36) questionnaires were applied to evaluate the QOL of coal miners. Multivariate stepwise regression analysis was used to assess the potential impact factors on QOL.

Results: The score of role limitations due to physical health problems (RP) dimension in underground miners was significantly lower than that of ground workers (P=0.005). Multivariate stepwise regression analysis showed that longer job tenure for dust exposure significantly lower coal miners' RP score. Comparing with normal populations, our subjects scored lower in both the physical health components (PHC) and the mental health components (MHC), and many factors accounted for it including job tenure for dust exposure, chronic disease, medical insurance, etc.

Conclusions: QOL of coal miners has been affected. Some measures might be taken by enterprise and coal miners themselves to protect the health of coal miners and improve their quality of life.

Keywords: Coal miners; quality of life (QOL); influence factors; 36-item Short-Form Health Survey (SF-36)

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Introduction

Coal industry is one of the national pillar industries in China and a large number of workers are involved in coal mining. It is reported that there were 4.7 million underground coal miners in 2010–2014 (1), who were exposed to a great deal of occupational hazards, including silica dust, coal dust, noise, vibration and heat, etc., which may lead to a various of occupational diseases such as pneumoconiosis, deafness, cardiovascular system disease and so on (2-4). Moreover, underground coal miners with

poorer working environment, higher working risk and greater working intensity which may increase occupational stress (5,6). Therefore, all of these factors may influence coal miners' physical and mental health (MH), that is to say, it is important to pay close attention to the life quality of underground coal miners.

Quality of life (QOL) is a multidimensional concept that contains physical, physiological, social heath and individual's satisfaction, and is widely accepted as an important end point in medical care (7,8). The 36-item Short-Form Health Survey (SF-36) questionnaire has been applied widely to assess QOL of people in many areas and studies (9-13). For example, a study which used SF-36 showed that the health-related quality of life (HRQL) of electric welders was significantly lower than ordinary people (14). QOL has been used in many researches, but few given insights into the QOL of underground coal miners, especially with SF-36 questionnaire (6). Moreover, with the improvement of working environment and self-protection awareness of coal miners, their QOL may much different from years before. In our study, we aimed to evaluate the QOL of coal miners in Xuzhou, China with SF-36 questionnaire in 2015, and identify the main influencing factors that contribute to the QOL, so as to provide a clue for the further preventive actions.

Methods

Design and subjects

In April 2015, we collected data on underground miners and ground workers in one of coal mines in Xuzhou, China. Eligibility criteria of study population included the following: (I) at least 1 year working experience in present job tenure; (II) clinically proven absence of pneumoconiosis; (III) aged 20 to 60 years old based on the common age range of the coal miners; (IV) the categorization of underground miners as mainly tunneling, mining, or other helping underground miners like ventilation workers, conveyor belt workers, etc., who largely work underground and are likely to exposure to coal dust. Ground workers as mostly technicians, support crew, administration staff, etc., who work above the ground and hardly exposure to coal dust. Totally, 1,002 subjects met criteria above were enrolled in the study. All subjects in the study were male.

We made face-to-face interviews. Informed consent was obtained from all individual participants included in the study. All the questionnaires were done by workers themselves under the guidance of investigators with unified training. Investigators checked questionnaires in the presence of participants for any errors to insure the completeness and accuracy of the questionnaires.

Instruments

The instruments used in our study consisted of two parts: one was the validated Mandarin version of SF-36 (15), and the other was socio-demographic factors and working factors questionnaire. Socio-demographic details covered age, smoking, drinking, education level, personal monthly income, marital status, place of residence, chronic disease, medical security, and body mass index (BMI). Working history included job type, job tenure, working hours per day, etc. Considering the coal mine was a state-owned enterprise, there had been a management system to supervise not only the usage for protective gear of each miner (e.g., face mask/filter), but also the safety of the work environment, such as underground automatic alarm devices, mine safety monitoring and control system, etc. Thus, we did not collect the data about usage of personal protective gear and safety of the work environment in the study.

BMI was calculated as weight in kilograms divided by the square of height in meters and categorized as definition by WHO (16). Smoking refers to at least one cigarette per day on average (or use other ways to consume the equivalent of tobacco of one cigarettes) and persistent smoking for more than 1 year. For drinking, only drinking in holidays means occasional drinking, drinking at least once a week means often drinking, and there is no consideration for the volume of alcohol consumed.

We calculate job tenure for dust exposure using the period between the start time and the end time of the underground working. The average working time for the underground coal mining and tunneling miners were 40 hours weekly (8 hours daily for 5 days). Other auxiliary underground jobs, such as ventilation, conveyor belts, etc., were 30 hours weekly (6 hours daily for 5 days). If job tenure for dust exposure of coal mining and tunneling miners equals to 1, other underground jobs equals to 0.75.

The SF-36 questionnaire was chosen to evaluate life quality of coal miners in our study. It is a simple and brief questionnaire including eight dimensions: physical function (PF), role limitations due to physical health problems (RP), bodily pain (BP), general heath (GH), vitality (VT), social function (SF), role limitations due to emotional problems (RE) and MH. The former four dimensions constitute

the physical health components (PHC), while the later four dimensions constitute the mental health components (MHC). And scoring of these domains was performed manually, with higher scores indicating better status of each dimension (14).

Statistical analysis

Epidata3.1 was used to input data and check logicality. All questionnaires were doubly input with manual and computer checking. SPSS20.0 was employed for statistical analysis, including *t*-test, chi-square test and one-ANOVA test for single factor analysis, and multivariate stepwise regression for multiple factors analysis. $P<0.05$ was considered statistically significant.

Results

Basic characteristics

Nine hundred and sixty-six male workers from 1,002 subjects completed questionnaires, including 612 (63.35%) underground miners and 354 (36.65%) ground workers. The total valid response rate was 96.41%.

The mean age of underground miners (n=612) was 41.57±9.26, and ground workers (n=354) was 43.72±9.21. *Table 1* shows general information of them. No significant differences were observed on age, smoking, drinking, marital status and BMI between two groups. However, the education level, monthly personal income, place of residence, chronic disease, medical security and job tenure for dust exposure of underground miners showed significant differences compared with ground workers. Totally, 60.7% of ground workers shared higher education than that of underground miners (48.2%), whereas monthly income levels of ground workers were less than that of underground miners. In addition, 252 (71.2% of 354) ground workers lived in town while the number of underground miners was 323 (52.8% of 612). Moreover, the rates of ground workers and underground miners who developed chronic disease were 16.7% and 10.6%, respectively. Of note, the medical insurance in underground miners was better than that of ground workers.

Considering that dust exposure irreversibly affects the health of coal miners, and many ground workers used to work underground for some time, we calculated job tenure for dust exposure in both underground miners and ground workers based on working history. The comparison between them showed underground miners exposure (15.31 years by average) significantly longer years than ground workers (80.2% less than 10 years).

Comparison of SF-36 for underground miners and ground workers

Table 2 shows that the means (M) of all dimensions of underground miners were lower than those of ground workers except for GH, in which only RP dimension was significant different between two groups.

Multivariable analysis of underground miners in role-physical dimension

To explore the influencing factors of underground miners in RP dimension, Single-factor analysis was applied in *Table 3*. Miners with longer job tenure for dust exposure, chronic disease etc. may result in lower score in RP. Further multivariate stepwise regression was used to adjust the influencing factors to explore the significant independent variables predicting miners' RP score. With independent variables shown in *Table 4* and the lowest category as the reference level, we found job tenure for dust exposure significantly influence miners RP dimension score in *Table 5*.

Comparison of QOL between coal miners and the norm

When comparing QOL scores in our study with normal population of Wuxi and Suzhou in Jiangsu province or in Sichuan province, we found that the total scores of QOL and PHC reduced more than 25 points compared with the either norm population in both underground miners and ground workers (*Table S1*). The total scores of QOL decline markedly by 69.55 and 82.87 points respectively in two groups compared with rural male in Sichuan (17-19).

Hence, we made several distinct models for the total scores, PHC, MHC domains of QOL to explore the influencing factors in underground miners and ground workers respectively (*Table 6*). For underground miners, chronic disease is main influencing factors in total score, PHC and MHC domains. Moreover, with longer job tenure for dust exposure and higher education level, miners suffered worse PHC and MHC domain respectively. For ground workers, with worse medical insurance and chronic disease, workers had lower total QOL score and PHC score; workers who were older also had lower PHC score; moreover, medical insurance was a negative factor influence

Table 1 Basic characteristics between two groups

Variables	Ground worker (n=354)	Underground miner (n=612)	χ^2	P
Age (year), n (%)			1.639	0.201
<40	114 (32.2)	222 (36.3)		
≥40	240 (67.8)	390 (63.7)		
Smoking, n (%)			0.429	0.512
No	129 (36.4)	236 (38.6)		
Yes	225 (63.6)	376 (61.4)		
Drinking, n (%)			0.374	0.541
No (including seldom drink)	258 (72.9)	457 (74.7)		
Yes	96 (27.1)	155 (25.3)		
Marital status, n (%)			0.351	0.839
Unmarried	14 (4.0)	28 (4.6)		
Married	331 (93.5)	566 (92.5)		
Divorced/widowed	9 (2.5)	18 (2.9)		
BMI (kg/m^2) , n (%)			1.155	0.561
<18.5	39 (11.0)	81 (13.2)		
≥18.5 to <25	270 (76.3)	460 (75.2)		
≥25	45 (12.7)	71 (11.6)		
Education level, n (%)			14.133	<0.001
Junior school and blow	139 (39.3)	317 (51.8)		
High school and above	215 (60.7)	295 (48.2)		
Average monthly income (RMB) , n (%)			140.944	<0.001
≤2,000	282 (79.7)	246 (40.2)		
>2,000	72 (20.3)	366 (59.8)		
Place of residence, n (%)			31.545	<0.001
Town	252 (71.2)	323 (52.8)		
Rural	102 (28.8)	289 (47.2)		
Chronic disease, n (%)			7.327	0.007
No	295 (83.3)	547 (89.4)		
Yes	59 (16.7)	65 (10.6)		
Medical security, n (%)			4.118	0.042
Good	230 (65.0)	436 (71.2)		
Bad	124 (35.0)	176 (28.8)		
Job tenure for dust exposure (year) , n (%)			161.800	<0.001
≥0 to <10	284 (80.2)	234 (38.2)		
≥10 to <20	40 (11.3)	166 (27.1)		
≥20 to <30	26 (7.3)	168 (27.5)		
≥30	4 (1.1)	44 (7.2)		

BMI, body mass index.

Table 2 Comparison of SF-36 for underground miners and ground workers

	Ground worker (n=354)		Underground miner (n=612)		*t*	P
	M	SD	M	SD		
PHC	296.66	64.19	289.58	69.69	1.563	0.118
PF	88.31	12.51	87.51	12.69	0.941	0.347
RP	77.49	34.27	70.88	37.46	2.792	0.005
BP	72.92	12.28	71.61	19.11	1.038	0.300
GH	57.94	21.54	59.58	21.46	1.144	0.253
MHC	286.83	71.27	280.68	74.83	1.249	0.212
VT	68.43	16.98	66.14	18.68	1.945	0.052
SF	80.95	19.64	80.94	20.03	0.004	0.997
RE	70.95	40.19	67.59	41.18	1.231	0.218
MH	66.50	17.22	66.01	16.93	0.426	0.670
Total score	583.49	123.80	570.26	132.43	1.529	0.127

SF-36, 36-item Short-Form Health Survey; PF, physical function; RP, physical health problems; BP, bodily pain; GH, general heath; VT, vitality; SF, social function; RE, emotional problems; MH, mental health; PHC, physical health components; MHC, mental health components; M, means; SD, standard deviation.

MHC domain. However, education level was positively influence workers QOL in both PHC and MHC domains, and the same as average monthly income in PHC domain.

Discussion

SF-36, as one of the most widely used life quality evaluation tool, has been validated with good reliability, validity, and practicability in many countries (20-24). It can be used for evaluation of population health, disease, health economics and clinical therapeutic effects. Many studies confirmed that it is available for Chinese population (25-28). Considering the coal miners exposed to multiple occupational hazards underground, their QOL is worthy of analysis and discussion. Our results revealed that underground miners had lower scores of SF-36 in RP dimension than ground workers, and job tenure for dust exposure was the main influencing factor accounting for it. Moreover, comparing with normal populations, our subjects had lower QOL scores, which were influenced by chronic disease, job tenure for dust exposure, education, etc.

The two subgroups of ground workers and underground miners showed no significant heterogeneity between age, smoking, drinking, marital status and BMI, while underground miners had longer job tenure for dust exposure, higher proportion of lower education level, higher average monthly income and feeling no chronic disease, etc. Considering that underground miners totally worked in the front-line, lower education level was required for them compared with ground workers, such as technical supervision and administrative personnel. With tough working environment, high working intensity and risk, underground miners earned more than ground workers. These findings of education level and monthly income were similar with Zhu's research (14). Besides, more ground workers lived in town with higher percentage of chronic diseases, which may be explained that ground workers mostly worked in the office with less exercise, thus more people suffered with chronic disease (29).

Our research revealed that the underground miners scored lower in almost all QOL dimensions, especially significantly in RP dimension, and job tenure for dust exposure accounted for the main influencing factor for it. That is to say underground miners encountered role limitations due to RP induced by job tenure for dust exposure. It is accepted that exposure to coal mine dust and/or crystalline silica results in pneumoconiosis with initiation and progression of pulmonary fibrosis (30). Pulmonary

Table 3 Single-factor analysis for underground miners in RP

Variables	Underground miner (n=612)			*t*	P
	n	M	SD		
Age (year)				1.031	0.303
<40	222	72.95	36.55		
≥40	390	69.70	37.95		
Smoking				0.524	0.600
No	236	71.88	36.29		
Yes	376	70.25	38.19		
Drinking				1.437	0.152
No (including seldom drink)	457	69.66	38.08		
Yes	155	74.48	35.41		
Education level				0.248	0.804
Junior school and blow	317	71.24	37.37		
High school and above	295	70.49	37.61		
Average monthly income (RMB)				0.195	0.846
≤2,000	246	71.24	37.51		
>2,000	366	70.64	37.47		
Marital status				0.825	0.439
Unmarried	28	62.50	38.19		
Married	566	71.16	37.35		
Divorced (widowed)	18	75.00	40.22		
Place of residence				0.908	0.364
Town	323	72.18	37.49		
Rural	289	69.42	37.43		
Chronic disease				1.252	0.211
No	547	71.53	37.32		
Yes	65	65.38	38.45		
Medical insurance				0.323	0.747
Good	436	71.19	37.64		
Bad	176	70.11	37.09		
BMI (kg/m^2)[a]				1.786	0.169
<18.5	81	67.83	37.12		
18.5–25	460	70.25	37.90		
≥25	71	78.44	34.42		
Job tenure for dust exposure (year)[b]				2.368	0.070
≥0 to <10	234	73.18	35.79		
≥10 to <20	166	74.48	35.41		
≥20 to <30	168	66.22	40.87		
≥30	44	62.82	38.25		

[a,b], one-ANOVA test was used. RP, physical health problems; BMI, body mass index; M, means; SD, standard deviation.

Table 4 Influencing factors and variable coding

Factors	Variable coding
Age (year)	<40 =1; ≥40 =2
Smoking	No =1; yes =2
Drinking	No =1; yes =2
Education level	Junior school and blow =1; high school and above =2
Average monthly income (RMB)	≤2,000 =1; >2,000 =2
Marital status	Married =1; unmarried =2; divorced/widowed =3
Place of residence	Town =1; rural=2
Chronic disease	No =1; yes =2
Medical insurance	Good =1; bad =2
BMI (kg/m^2)	<18.5 =1; 18.5–25 =2; ≥25 =3
Job tenure for dust exposure (year)	<10 =1; 10–20 =2; 20–30 =3; ≥30 =4

BMI, body mass index.

Table 5 Multivariate stepwise regression results of underground miners in RP

Dependent variable	Independent variable	Regression coefficient	Standardized regression coefficient	*t*	P
RP	Job tenure for dust exposure	−3.519	−0.091	−2.265	0.024

RP, physical health problems.

fibrosis is an untreatable lung disease which can be fatal, resulting in huge physical and mental health for patients (31). It was supported that the incidence of pneumoconiosis was positively correlated with cumulative dust exposure years (32,33). Therefore, the longer job tenure for dust exposure, the worse RP score for underground miners. In order to reduce the inhalation of coal dust, coal miners should make sure to use individual protective gear correctly before working, such as face masks and earplugs; the enterprise should improve technology including ventilation, isolation and automation to reduce dust concentration of working environment.

The comparison of SF-36 between subjects and the norm showed that both ground workers and underground miners' QOL were lower than normal populations. Thus, we did further multiple stepwise regression analysis for our two subgroups respectively. Job tenure for dust exposure, chronic disease, and education level negatively influenced life quality of underground miners. Except for focusing on the methods to reduce coal dust inhalation, more attention should be paid for coal miners' disease history, provide correct medical guidance for them to reduce chronic disease. It is interesting to find that underground miners had lower life quality scores with higher education level, which was opposite in ground workers. It may hint that underground miners with higher education level may feel psychological imbalance resulting in less scores, while higher education level was more common among ground workers, and ground workers with higher education level were usually regarded as more capable and higher income, leading to higher scores. Other QOL influencing factors for ground workers were medical insurance and chronic disease, indicating that not only for underground miners, but also for ground workers, the more social support they have, including supporting from company, family and the society, the higher life quality they get.

In conclusion, the life quality of underground miners was poorer and mainly influenced by job tenure for dust exposure. It admits of no delay to keep on reducing coal dust in working environment with advanced dust control technology, high level of automation, and reinforced supervision on personal protective gear wearing. Otherwise,

Table 6 Results of multiple stepwise regression analysis for QOL

Dependent variable	Independent variable	Regression coefficient	Standardized regression coefficient	*t*	P
Underground miners					
Total score	Chronic disease	−56.717	−0.109	−2.703	0.007
PHC	Job tenure for dust exposure	−8.290	−0.116	−2.850	0.005
	Chronic disease	−21.106	−0.093	−2.302	0.022
MHC	Chronic disease	−23.629	−0.097	−2.407	0.016
	Education level	−13.459	−0.090	−2.224	0.027
Ground workers					
Total score	Medical insurance	−62.898	−0.243	−4.819	<0.001
	Education level	55.598	0.220	4.328	<0.001
	Chronic disease	−41.804	−0.126	−2.495	0.013
PHC	Age	−16.559	−0.121	−2.093	0.037
	Chronic disease	−31.514	−0.183	−3.612	<0.001
	Medical insurance	−24.365	−0.181	−3.667	<0.001
	Education level	21.093	0.161	2.829	0.005
	Average monthly income	17.931	0.113	2.253	0.025
MHC	Medical insurance	−36.533	−0.245	−4.766	<0.001
	Education level	24.951	0.171	3.332	0.001

QOL, quality of life; PHC, physical health components; MHC, mental health components.

both underground miners and ground workers had lower QOL sores comparing with normal populations, and chronic disease, medical insurance, education level, etc. were influencing factors. Therefore, coal miners should be paid more social support and care from the surroundings. Our study revealed the life quality and influencing factors of coal miners, while limited in one of coal mines in Xuzhou, China, further larger well-designed studies still await.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

Ethical Statement: The study was approved by the Ethics Committee of Nanjing Medical University and informed consent was obtained from all individual participants included in the study.

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Supplementary

Table S1 Comparison of QOL between coal miners and the norm

QOL dimension	Sichuan city male	Sichuan rural male	Wuxi male (n=455)	Suzhou male (n=1,471)	Ground workers (n=354)	Underground miners (n=612)
PHC	327.45	335.04	324.70	325.15	296.66	289.58
PF	89.70	92.98	89.90	91.56	88.31	87.51
RP	81.68	81.94	85.60	83.31	77.49	70.88
BP	87.16	88.76	85.40	85.48	72.92	71.61
GH	68.91	71.36	63.80	64.80	57.94	59.58
MHC	283.50	318.00	298.40	295.10	286.83	280.68
VT	66.43	72.77	64.80	70.70	68.43	66.14
SF	79.46	90.31	81.70	82.52	80.95	80.94
RE	70.29	79.33	82.30	71.95	70.95	67.59
MH	67.32	75.59	69.60	69.93	66.50	66.01
Total score	610.95	653.04	623.10	620.25	583.49	570.26

QOL, quality of life; PF, physical function; RP, physical health problems; BP, bodily pain; GH, general heath; VT, vitality; SF, social function; RE, emotional problems; MH, mental health; PHC, physical health components; MHC, mental health components.